National Aeronautics and Space Administration

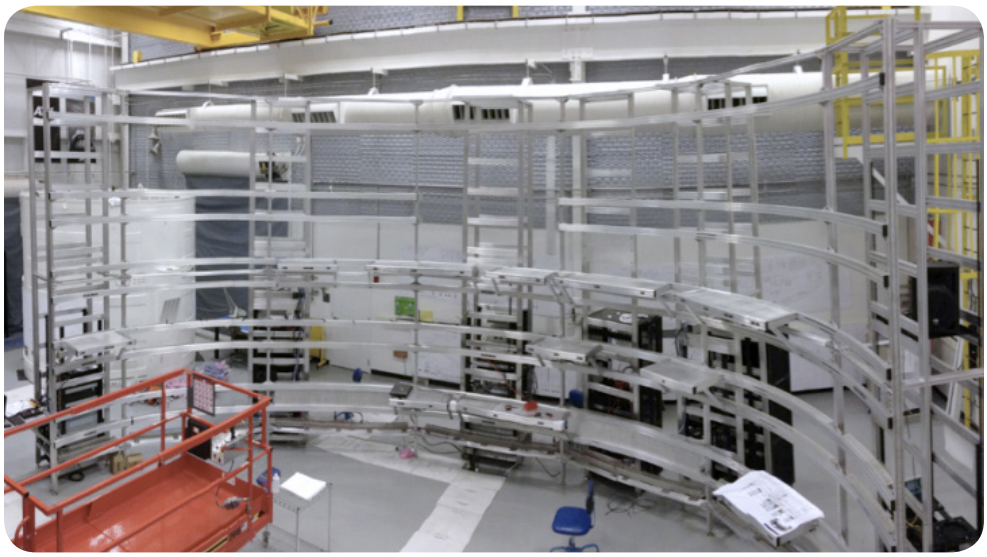
Space Launch System
Highlights

August 2013

Avionics: The Central Nervous System of NASA's Space Launch System

The nervous system in the human body controls everything a person does, including walking, thinking and feeling. Avionics is much like that complex collection of nerves and cells, only instead of a human body, it will guide the Space Launch System (SLS) to deep-space missions.

"The body couldn't function without the nervous system, and similarly, SLS couldn't fly without avionics," said Lisa Blue, stages avionics system manager in the SLS Program Office at NASA's Marshall Space Flight Center in Huntsville, Ala. Avionics and flight software are being tested and developed at Marshall. "Avionics will tell the rocket things like where it should go and end up, and how it should gimbal, or pivot, the engines to keep on the right trajectory." Avionics and the flight computer will be housed in the SLS core stage.



The primary hardware infrastructure for the System Integration Test Facility is being constructed at Marshall. The configuration of the structure is designed to functionally represent the forward skirt, intertank and engine section of the SLS core stage, where avionics components are located. The structure supports the mounting of flight-equivalent avionics boxes and flight-length cables in addition to simulation and test system components. *(NASA/MSFC)*

Preparing for Flight

The SLS avionics team at Marshall has received six of seven core stage flight computer development units from The Boeing Company. The units

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From left, Wayne Arrington and Richard Gilbert, both Boeing employees supporting Marshall's Stages Office; and Lisa Coe, an engineer in the Stages Office, perform a demonstration of a SLS fly-out from the System Integration Test Facility control room. This demonstration goes from prelaunch to all the stages of the vehicle separation events, including booster separation, engine cut off and Orion spacecraft separation. *(NASA/MSFC)*

Avionics

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are being used to develop the flight software for the SLS. The other development unit is scheduled to be delivered in December.

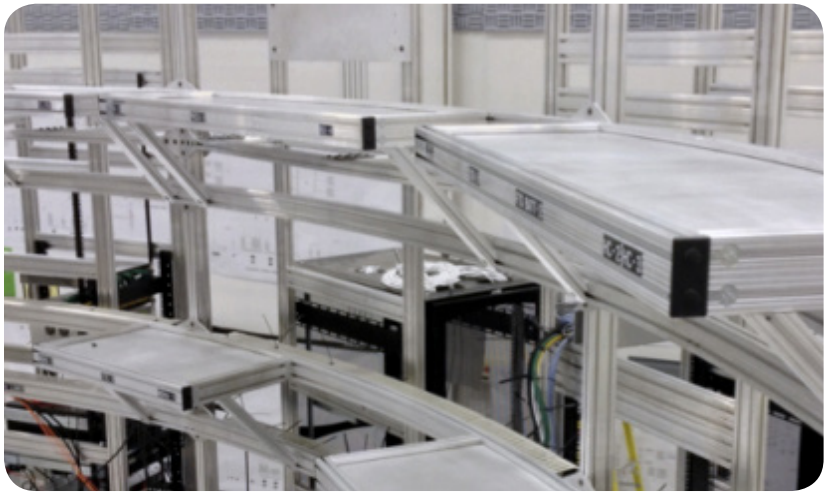
The SLS flight computer has the highest processing capability available in a flight avionics computer and is being developed by upgrading existing component and board designs that have been used in communication satellites.

"The flight software development and testing is underway at Marshall's Software Development Facility in an effort to rapidly mature and ensure implementation of a safe and highly reliable avionics and software system," Blue said.

Once testing is complete at the Software Development Facility, the launch vehicle's software will be installed and tested in the System Integration Test Facility later this year at Marshall.

"This will be the first time we'll have all the hardware and software, and be able to test them as a cohesive system—a big step for avionics being ready for the first flight of SLS," Blue said. "These units will be replicating what will actually fly the rocket, and we'll run simulations to see how SLS will perform in space."

All avionics components have completed their preliminary design review, and many have completed critical design review, two agency milestones that must be passed to show that systems, cost and schedule requirements can be met. In 2015, the avionics will be shipped to NASA's Michoud Assembly Facility in New Orleans, where the core stage is being manufactured and integrated onto the actual rocket.



(NASA/MSFC)

(NASA/MSFC)

Spaceflight Partners: Southern California Braiding

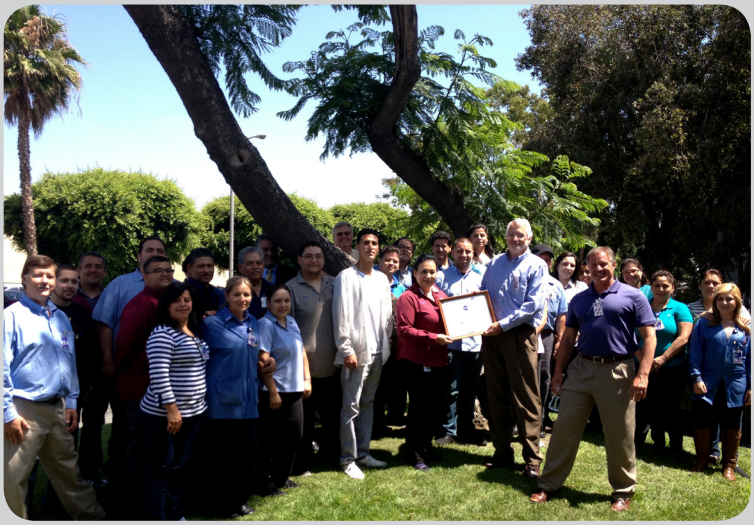
EDITOR'S NOTE: Every month, SLS Highlights turns the spotlight on one of the industry partners helping to create the largest rocket ever built for human space exploration. In this issue, we profile Southern California Braiding in Bell Gardens, Calif.

Every rocket booster needs harnesses for communications and power, among other things. In the case of the solid rocket boosters on the SLS that are manufactured by Alliant Techsystems, also known as ATK, those harnesses are manufactured by Southern California Braiding (SCB) Inc. of Bell Gardens, Calif.—under contract with ATK.

SCB has provided military- and space program-related wire harnesses, cable assemblies and electro-mechanical assemblies since April 1, 1974. SCB also provided cargo bay integration cables for missions STS-127, STS-128 and STS-134 in support of NASA's Space Shuttle Program.

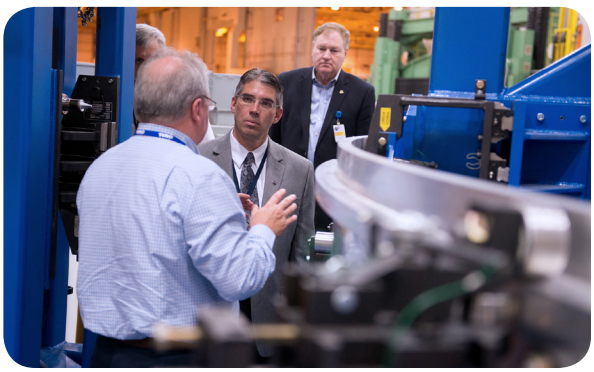
SCB has delivered 50 cables for System Level Development (SLD) testing. The SLD test series is an integrated test of the entire avionics system for SLS and a precursor series of tests prior to system qualification. The test series is a major milestone required before flight. Biweekly deliveries will continue until completion.

The harnesses are made of individual wire bundles that allow communication and power to be transmitted. Each wire is inserted into its corresponding connector receptacle before an overbraid is placed on the outside of these wires to keep them together. A braiding machine is used to weave the overbraid on the outside of the wires. The combination of wires, connector, overbraid and other items are what make up a harness. In turn, the harnesses connect the avionics boxes together.



Representatives from NASA and ATK visit Southern California Braiding in July. The company was recognized as a superior supplier. *(ATK)*

SCB has a number of core competencies beyond cabling, such as strict electromagnetic interference and electromagnetic pulse applications. SCB also has Magnaform termination available—an important capability for long-duration spaceflight. SCB was selected as NASA's Marshall Space Flight Center 2010 Small Business Subcontractor of the Year and recognized in June 2013 by NASA as a superior supplier.



Michael Gazarik Tours Michoud

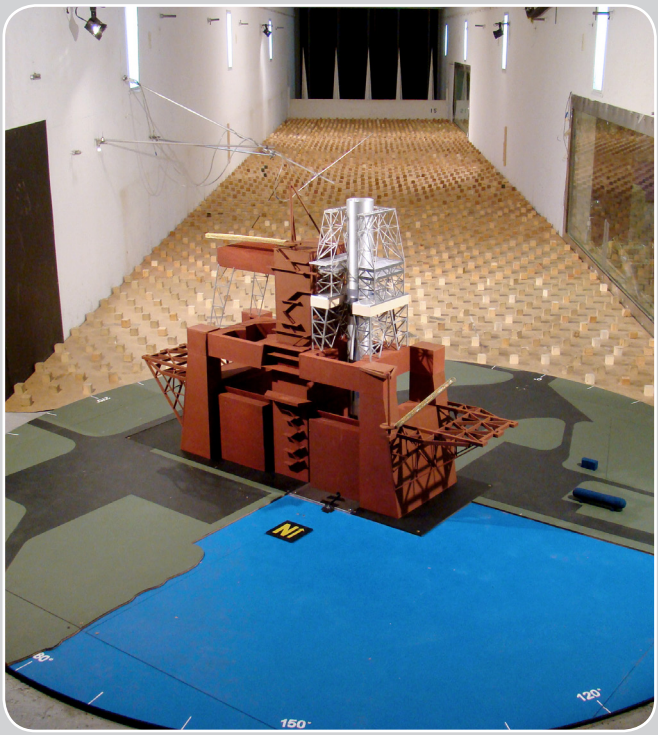
Michael Gazarik, center, associate administrator of NASA's Space Technology Mission Directorate, checks out the segmented ring tool Aug. 6 at NASA's Michoud Assembly Facility in New Orleans. The segmented ring tool will use a friction-stir-weld process to produce segmented support rings for the SLS core stage. The rings connect and provide stiffness between domes and barrels. Gazarik toured the Michoud facility to get a first-hand look at progress being made on the SLS. *(NASA/Michoud)*

Scale Model of SLS B-2 Test Stand Successfully Completes Wind Tunnel Testing

A 1:100 (31-inch) scale model of the SLS core stage B-2 test stand successfully completed wind tunnel testing Aug. 8. The actual B-2 test stand, located at NASA's Stennis Space Center in Mississippi, was originally built to test Saturn rocket stages that propelled humans to the moon. It is being completely renovated to test the core stage of the SLS in late 2016 and early 2017.

"The scale model was exposed to varying wind speeds at different angles," said John Rector, SLS Stages Green Run test manager in the Stages Office at NASA's Marshall Space Flight Center in Huntsville, Ala. "Test stand designers used the test as a way to validate the structure meets current building codes. We want to maximize the capacity of the structure, while minimizing the amount of steel used—which reduces costs."

The wind tunnel testing was performed by NASA subcontractor CPP Wind Engineering & Air Quality Consultants at its facility in Fort Collins, Colo. The SLS core stage, with four RS-25 rocket engines, will be installed on the stand for propellant fill and drain testing and two hot fire tests. Click **here** for more information about the B-2 stand being prepared for SLS core stage testing. *(NASA/Stennis)*



NASA Continues Preparation for SLS Engine Testing at Stennis

A welder at NASA's Stennis Space Center works on a portion of piping to be installed on the A-1 test stand for RS-25 rocket engine testing. NASA is scheduled to begin testing RS-25 engines next spring for use on the SLS. *(NASA/Stennis)*

Think about negotiating an intricate maze, and you begin to appreciate the challenge of designing and fabricating test stand piping for NASA's RS-25 rocket engine.

NASA is meeting that challenge at its Stennis Space Center near Bay St. Louis, Miss., where piping for liquid oxygen and liquid hydrogen is being produced for RS-25 engine testing on the A-1 test stand. Testing of the core-stage engine for SLS is scheduled to begin next spring.

"This is a big undertaking," said Robert Ek, systems engineer for the RS-25 test project at Stennis. "These are massive lines, weighing hundreds of pounds, and they have to be threaded through a great deal of other stand equipment and structure needed for testing. It's a real challenge."

NASA engineers are now conducting gimbal, or pivot, testing on a J-2X engine on the A-1 stand, but that hot fire

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NASA Continues Preparation

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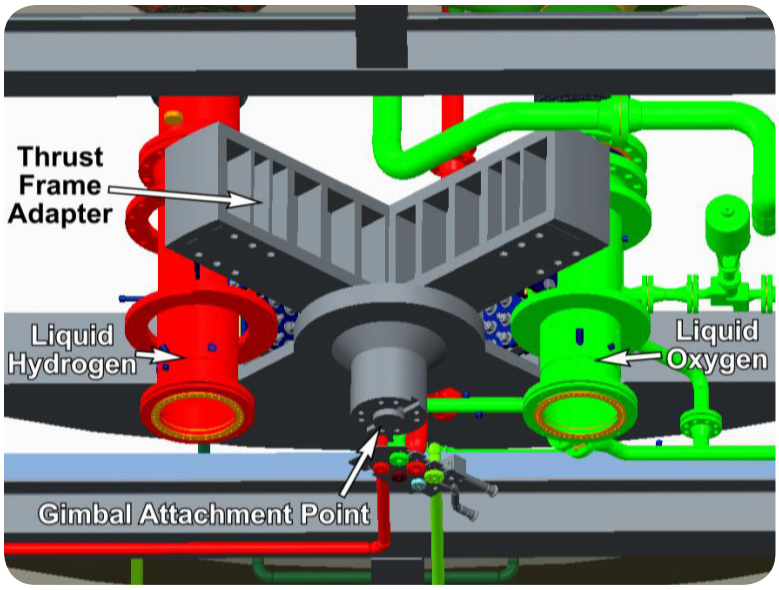
series is scheduled to end in early September. Stand equipment must then be modified to meet RS-25 rocket engine drawing and specification requirements. A new thrust frame adapter has already been fabricated for installation on the stand this fall. Fabrication of the new piping system is underway.



Fabrication is underway on piping that will carry liquid oxygen and liquid hydrogen for RS-25 engine testing on the A-1 test stand at Stennis. Fabrication of the piping presented a design challenge—it has to be threaded through a great deal of other stand equipment and structures. *(NASA/Stennis)*

Design of the piping was an involved process that required collecting a lot of information about the RS-25 engine and its performance specifications. Even though RS-25 engines were used as space shuttle main engines, some modifications will be made before testing begins.

"Even with the RS-25 engine's flawless performance on all 135 space shuttle missions, a different rocket like SLS has new environmental and thrust conditions and therefore different test considerations," said Mike Kynard, SLS Liquid Engines program manager at NASA's Marshall Space Flight Center. "Anytime we make changes to an engine, or to environmental conditions in which it will run, we'll need to put it through a full set of tests. What we typically do in the rocket engine industry is run things twice as long as we plan to use them in flight to ensure the robustness of the design. We run it at different conditions to make sure we've covered the full range of the design."

Engineers had to take into account new engine performance factors to determine such things as the flow rate of cryogenic fuels needed in the lines and the pressures under which they must operate. In terms of simple geometry, they also had to make sure piping connections were located properly and identify how and where to install supports to hold the piping in place.

"Negotiating a maze is a good analogy," Ek said. "There was a lot of ingenuity and working together to make sure good decisions were made. The design engineering team, supported by both operations and systems engineering, did a great job in finding answers along the way."

The RS-25 testing project was accelerated by a few months, shortening the time for preparation work on the A-1 test stand. The piping now being fabricated by Jacobs Technology crews at Stennis is expected to be completed and installed on the stand by the end of the year.

Once in place, the lines will be sealed and tests performed to make sure there are no leaks in the system and that they perform properly at the extremely low temperatures required to flow liquid oxygen and liquid hydrogen propellants. The first installation of an RS-25 engine will be in early April 2014, with a series of liquid oxygen chill tests and eight hot fire tests to follow.

Once tested and certified, the engines will be used for both SLS test flights and operational missions, a fact that Ek and others at Stennis find gratifying. "I used to work on space shuttle main engines during the Space Shuttle Program," Ek said. "That program has ended, but the engines live on to fly again. It's very exciting to help make that happen."

SLS On the Road…

NASA recently took part in the **EAA AirVenture** in Oshkosh, Wis. The event, in its 60th year, celebrates the past, present and future of the world of flight. Representatives from NASA and SLS Program prime contracting companies attended the event, showcasing the SLS and Orion spacecraft and their innovation and mission capabilities. Activities included a Space Exploration display; astronaut presentations; a ham radio contact with current International Space Station occupants; an asteroid presentation; and a media briefing with executives from NASA and its contractors Lockheed Martin, Boeing, ATK and Aerojet Rocketdyne. Visiting the SLS booth at the event are, from left, Mike Parrish, Jacobs Technology; Dan Dumbacher, deputy associate administrator for NASA's Exploration Systems Development division; Kevin Barre, Lockheed Martin; Jan Kunzler, ATK; and Tim Sweeney, L-3 Communications. *(ATK)*

SLS Program Manager Todd May, at podium, talks about the importance of science, technology, engineering and mathematics (STEM) education to NASA on Aug. 21 at Lincoln Academy in Huntsville, Ala. *(NASA/MSFC)*

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